Remarks/Arguments

Claims 8-11 are pending in the present application, claims 1-7 having been withdrawn as directed to non-elected subject matter.

In view of the remarks presented below, Applicant respectfully requests favorable reconsideration and allowance of Claims 8-11.

In the Office action of February 1, 2006, the Examiner withdrew the rejection of claims 8-11 as anticipated under 35 U.S.C. 102(e) based on U.S. Pat No. 6,475,673 (Yamawaki) in favor of a new ground of rejection. Therefore Applicant's arguments to the effect that Yamawaki does not anticipate claims 8-11 were deemed moot.

Claims 8-11 stand rejected under 35 U.S.C. 103(a) as being unpatentable for obviousness over Yamawaki. The Examiner alleged that Yamawaki teaches a lithium ion battery having a lithium titanate compound, $Li_4Ti_5O_{12}$. The Examiner further alleged that the particle size thereof "is in the range of 0.1 to 15 μm, and is more preferably in the range of 0.5 to 5 μm," citing Yamawaki at col. 4, lines 14-21.

The Examiner considered Applicant's arguments but disagreed with Applicant's interpretation of the range of particle sizes disclosed or suggested by Yamawaki. The Examiner alleged that Yamawaki discloses particle sizes including 100 nm (the lowermost particle size), much as it includes 15 μm (the uppermost particle size). The Examiner further interpreted the cited language from Yamawaki as particle sizes in the range of 100 nm, inclusive of 100 nm, up to and including 15 μm and points in the range of 15 μm. Thus, the Examiner interpreted the lowermost particle size in the range of 100 nm as including 99 nm, 100 nm. The Examiner concluded that at least to the skilled artisan, Yamawaki teaches the presently claimed less than 10 nm for lithium titanate insofar as particle sizes in the range of 100 nm, as exemplified in Yamawaki, overlap therewith.

To the extent Applicant's arguments were applicable to the present ground of rejection, the Examiner fully considered those arguments found them unpersuasive.

With respect to Applicant's arguments that Yamawaki prefers particle sizes much larger than 100 nm "perhaps because of the notion that nanomaterials are detrimental to the performance of the battery," the Examiner alleged that attorney argument is not the kind of factual evidence required to rebut a prima facie case of obviousness, such as that which is presently relied upon as a new ground of rejection, citing MPEP 2145.

With respect to Applicant's assertion of evidence of extraordinary benefits such as high energy storage capacity and high recharge rates, the Examiner found it unclear as to where in the disclosure this evidence had been derived. While Applicant urged that Fig. 5 teaches superior capacity of smaller lithium titanate particles compared with larger particle sizes, the Examiner understood Fig. 5 merely to show capacity levels as a function of cycle rates. While applicant urged that Fig. 7 shows the unexpected stability of that capacity, the Examiner understood Fig. 7 as merely showing the capacity level during cycle usage. Furthermore, the Examiner asserted that any assertions of unexpected results would need to show a direct comparison of the prior art's teaching of particle sizes in the range of 100 nm as compared to applicant's claimed particle sizes less than 100 nm. The examiner also asserted that to the extent Applicant's disclosure is understood by the Examiner, the Examiner found no evidence of comparative results commensurate with these values.

The Examiner considered Applicant's arguments as to claim 9, but did not find them persuasive and therefore maintained the previous rejection of claim 9 in reciting product-by process limitations to obtain the instant lithium titanate intercalation compound.

Applicant and Counsel met with the Examiner on March 24, 2006 in an effort to overcome the Examiner's objections to the pending claims. Applicant would like to thank the Examiner for his helpful comments and for the opportunity to meet with him. During the

interview, the Examiner admitted that his interpretation of the range of particle sizes disclosed or suggested by Yamawaki had been in error. The rest of the discussion centered around differences between the prior art and the present claims. Agreement was reached during the interview since it appeared to the Examiner that an amendment drawn to a nanostructure primary particle size would overcome the present grounds of rejection.

As a follow-up to the interview, Applicant has amended claim 8 to claim a nanostructured particulate lithium titanate intercalation compound comprising an average primary particle size of less than 100 nm. Applicant also has amended claims 9-11 to be consistent with the amendment to claim 8 and to incorporate the phrase "average primary particle" in these claims. Support for these amendments may be found throughout the specification, particularly paragraphs [0008] and [0009].

As discussed during the interview, Applicant urges that Yamawaki is not a proper a proper obviousness reference because Yamawaki does not contain either detailed enabling methodology for practicing the invention without undue experimentation, or a suggestion to modify the prior art to practice the claimed invention, or evidence suggesting that the modification would be successful in achieving the invention. See *In re O'Farrell*, 853 F.2d 894, 901, 7 U.S.P.Q.2d 1673, 1681 (Fed. Cir. 1988); *In re Nunberg,* 33 U.S.P.Q.2d 1953 (Fed. Cir. 1994); *In re Vaeck*, 947 F.2d 488, 493, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991).

The present invention is patentably distinguished from Yamawaki. As taught by the example in col. 5-6, Yamawaki starts from macrostructured particles, and attempts to break them into particles "in the range of 0.1 to 15 μm" by crushing them. There is no showing in Yamawaki that starting from macrostructure Yamawaki achieved nanostructure. As disclosed in para. [0009], the process of the present invention starts from nanostructured TiO_2 and a lithium precursor, prevents heat-induced growth of the synthesized $Li_4T_5O_{12}$ final product, and preserves the nanostructure of that compound.

Fig. 2 of the present invention depicts the relative sizes of primary particles resulting from annealing for different time periods. Fig. 2a depicts a Scanning Electron Micrograph (SEM) of synthesized $Li_4T_5O_{12}$ produced after 120 minutes of annealing time; Fig. 2b depicts an SEM of synthesized $Li_4T_5O_{12}$ produced after 60 minutes of annealing time, and Fig. 2c depicts $Li_4T_5O_{12}$ produced after 15 minutes of annealing time. The specification teaches that even starting from nanostructure precursors, the primary particle size of synthesized grows from nanostructure particles (i.e., particles having an average size 40 nm in Fig. 2c) to macrostructure particles (i.e., particles having an average size of about 120 nm at 60 minutes (Fig. 2b), 205 nm at 120 minutes (Fig. 2a) and 480 nm at 16 hr). Therefore the process of the present invention starts with a nanostructured starting material and limits growth of the synthesized product to a maximum of <100 nm. As pointed out during the interview, Fig. 2(c) shows that the $Li_4T_5O_{12}$ aggregate of the present invention is composed of discrete nanostructured particles comprising an average primary particle size of less than 100 nm, as claimed in claim 8.

During the interview, Applicant brought to the Examiner's attention a recent review article in Science (Nel, Andre, Xia, Tian, Madler, Lutz; and Li, Ning, "Toxic Potential of Materials at the Nanolevel," *Science* 311 (5761): 622-627 (2006)), which is attached herein as an Appendix. The articles cited in this review article were published between 1995 and 2005. This reference, while dated after the date of the present invention, is offered as evidence of the level of skill in the art and knowledge in the art at the time the invention was made. *See Gould v. Quigg*, 822 F.2d 1074, 1078 (Fed. Cir. 1987). During the interview, Dr. Amatucci pointed out that this article explains that nanomaterials, are not simply materials in the nanometer range. The article discloses that at the time of the present invention, it was known that the properties of nanomaterials differ substantially from those of bulk materials of the same composition. More specifically, it teaches that the unusual physicochemical properties of engineered nanomaterials

are attributable to their small size (surface area and size distribution), chemical composition (purity, crystallinity, electronic properties, etc.), surface structure (surface reactivity, surface groups, inorganic or organic coatings etc.), solubility, shape and aggregation. (Id.) Moreover, Fig. 1 shows the inverse relationship between particle size and number of surface expressed molecules., i.e., in the size range less than 100 nm, the number of surface molecules rapidly increases relative to the number of bulk. (Id). The authors teach that because the number of atoms or molecules on the surface of the particle may determine the material reactivity, this is key to defining the chemical and biological properties of nanoparticles. (Id.)

In the Office action, the Examiner asserted that any assertions of unexpected results would need to show a direct comparison of the prior art's teaching of particle sizes in the range of 100 nm as compared to applicant's claimed particle sizes less than 100 nm. As explained during the interview, that comparison is shown in Fig. 5.

Fig. 2 as described above relates to Fig. 5, which shows the unexpected difference in capacity between macroparticulate $Li_4T_5O_{12}$ and the nanostructured $Li_4T_5O_{12}$ of the present invention. Fig. 5 compares the capacity level retained by cells comprising synthesized $Li_4T_5O_{12}$ particles produced after 15 min (average primary particle size <100 nm), 30 min, 60 min (average primary particle size 120 nm), 120 min (average primary particle size 205 nm) , 240 min (average primary particle size >205 nm) and 960 min (average primary particle size >480 nm) of annealing. The X axis is cycle rate, where 1C corresponds to a rate which discharges the cell in 1 hour; 5C corresponds to a 12 minute discharge rate, and 10C corresponds to a 6 minute discharge rate. The Y axis is retained capacity. Fig. 5 shows that as the annealing time shortens and the $Li_4T_5O_{12}$ particles get into the nano range, the nanostructure $Li_4T_5O_{12}$ particles show 90% retention of their capacity from 1C to 10C. Therefore as the particles get into the nano region there is a huge difference in their retained capacity compared to the retained capacity of the much larger particles shown. Fig. 7 further shows that a cell comprising the

nanostructure $Li_4T_5O_{12}$ particles of the present invention retains a capacity of just less than 150 mAh/g over more than 600 cycles.

As for claim 9, which is a product-by-process claim, Applicant urges that it is the process of the present invention that takes a nanostructured TiO_2 starting material and a lithium precursor, prevents heat-induced growth of the synthesized $Li_4T_5O_{12}$ final product, and preserves the nanostructure of the $Li_4T_5O_{12}$ compound.

Applicant respectfully requests that the 103 (a) rejection should be withdrawn since the Examiner has not established either a basis for modifying the Yamawaki reference or a reasonable degree of predictability of success in any proposed modification of Yamawaki that would lead a person of skill in the art to achieve the invention described and claimed in the present application.

Because there is no prior art which teaches or suggests the claimed invention, Applicant further respectfully requests that the Examiner withdraw all objections to and rejections of the present invention.

Applicant urges that this application is now in condition for allowance and earnestly solicits early and favorable action by the Examiner. If the Examiner believes that issues may be resolved by a telephone interview, the Examiner is respectfully urged to telephone the undersigned at (973) 597-6170. The undersigned also may be contacted via e-mail at blubit@lowenstein.com.

AUTHORIZATION

The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account No. 501,358.

Respectfully submitted,

Lowenstein Sandler PC

By:

Date: April 20, 2006

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